

CLAIMS

1. A dispenser for discrete droplets of less than ten microlitres ($10\ \mu\text{l}$) in volume of a liquid comprising:-
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- (A) a main assembly;
- (B) a liquid container comprising:-
- 10 an elongated body member having a straight main bore;
- an inlet to the main bore;
- 15 a valve seat in the body member forming a main bore outlet remote from and substantially in line with the inlet;
- a nozzle mounted on the body member and having a nozzle bore communicating with the valve seat;
- 20 a droplet dispensing tip on the nozzle remote from the valve seat;
- 25 a separate elongated floating valve boss of magnetic material loosely mounted in the main bore for limited movement out of line with the main bore, its cross-sectional area relative to that of the main bore being such as to permit the free flow of liquid between the main bore inlet and outlet by passing the valve boss, said valve boss not being mechanically connected to the body member;
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- (C) means for releasably securing the liquid container to the main assembly;
- (D) means for exerting a pressure differential on the liquid in the

dispenser; and

5 (E) a separate valve boss actuating assembly adjacent the body member for applying an electromagnetic force to the valve boss to engage and disengage the valve boss from the valve seat.

2. A dispensing assembly as claimed in claim 1 in which the valve boss is of a hard magnetic material.
- 10 3. A dispensing assembly as claimed in claim 1 in which the valve boss is covered with a layer of soft polymer.
4. A dispensing assembly as claimed in claim 1 in which the valve boss is manufactured from a flexible polymer bonded magnetic material.
- 15 5. A dispensing assembly as claimed in claim 1 in which the valve boss actuating assembly is an electrical coil surrounding the body member.
- 20 6. A dispensing assembly as claimed in claim 1 in which the valve actuating assembly comprises two separate sets of coils for moving the valve boss in opposite directions within the body member of the liquid container.
- 25 7. A dispensing assembly as claimed in claim 1 in which the valve actuating assembly comprises two separate coils for moving the valve boss in opposite directions within the body member of the liquid container, a source of electrical power and a controller for varying the current over time as each droplet is being dispensed.
- 30 8. A dispensing assembly as claimed in claim 1 in which the valve actuating assembly comprises a permanent magnet and means for moving the magnet along the body member of the liquid container towards and away from the valve seat.
9. A dispensing assembly as claimed in claim 1 in which the valve boss

actuating assembly comprises a permanent magnet substantially U shaped to embrace the body member and means for moving the magnet along the body member of liquid container towards and away from the valve seat.

- 5 10. A dispensing assembly as claimed in claim 1 in which valve actuating assembly comprises a pair of spaced apart magnetizing assemblies each comprising a coil wrapped around a core of soft magnetic material.
- 10 11. A dispensing assembly as claimed in claim 1 in which the valve actuating assembly comprises a pair of spaced-apart magnetising assemblies each comprising a coil wrapped around a substantially U-shaped core for embracing the body member.
- 15 12. A dispensing assembly as claimed in claim 1 in which the valve boss comprises a cylindrical plug having radially extending circumferential fins whereby movement of the boss towards the valve seat liquid is urged into the nozzle bore and onto the tip.
- 20 13. A dispensing assembly as claimed in claim 1 in which the body member and the nozzle form an integral moulding of plastics material.
- 25 14. A dispensing assembly as claimed in claim 1 in which the body member and nozzle are made from metal.
- 30 15. A dispensing assembly as claimed in claim 1 comprising;
- an electrode incorporated in the dispensing tip;
- a separate receiving electrode remote from the tip; and
- a high voltage generating means connected to one of the electrodes to provide an electrostatic field therebetween.
16. A dispensing assembly as claimed in claim 1 comprising;

an electrode incorporated in the dispensing tip;

a separate receiving electrode below the tip; and

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a high voltage generating means connected to one of the electrodes to provide an electrostatic field therebetween.

17. A dispensing assembly as claimed in claim 1 comprising:-

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an electrode incorporated in the dispensing tip;

a separate receiving electrode remote from the tip ;

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a high voltage generating means connected to one of the electrodes to provide an electrostatic field therebetween; and

a droplet receiving substrate mounted between the receiving electrode and the dispenser tip .

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18. A dispensing assembly as claimed in claim 1 comprising;

an electrode incorporated in the dispensing tip ;

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a separate receiving electrode remote from the tip including a hole for the passage of a droplet therethrough;

a droplet receiving substrate mounted below the receiving electrode; and

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a high voltage generating means connected to one of the electrodes to provide an electrostatic field therebetween.

19. A dispensing assembly as claimed in claim 1 comprising;

- an electrode incorporated in the dispensing tip ;
- 5 a plurality of separate receiving electrodes remote from the tip each having a hole for the passage of a droplet therethrough;
- a droplet receiving substrate mounted below the receiving electrodes;
- 10 means for activating the receiving electrodes separately; and
- a high voltage generating means connected to one of the electrodes to provide an electrostatic field therebetween.
- 15 20. A dispensing assembly as claimed in claim 1 comprising;
- an electrode incorporated in the dispensing tip ;
- 20 a separate receiving electrode remote from the tip;
- a droplet receiving substrate mounted below the receiving electrode;
- a high voltage generating means connected to one of the electrodes to provide an electrostatic field therebetween; and
- 25 synchronous indenting means for the dispenser and the receiving electrode for accurate deployment of droplets on the substrate.
21. A dispensing assembly as claimed in claim 1 comprising;
- 30 an electrode incorporated in the dispensing tip ;
- a plurality of separate receiving electrodes forming droplet deflection electrodes remote from the tip;

a droplet receiving substrate mounted below the deflection electrodes;

5 a high voltage generating means connected to one of the deflection electrodes to provide an electrostatic field therebetween; and

control means to vary the voltage applied to the deflection electrodes.

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22. A dispensing assembly as claimed in claim 1 comprising a detector for sensing the separation of the droplet from the dispensing tip.

15 23. A dispensing assembly as claimed in claim 1 comprising a detector for sensing the separation of the droplet from the dispensing tip, the detector comprising:

a source of electromagnetic radiation;

20 means for focussing the radiation on the end of the dispensing tip; and

means for collecting the radiation coupled by a droplet on the dispensing tip.

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24. A dispensing assembly as claimed in claim 1, comprising a detector for sensing the separation of the droplet from the dispensing tip, the detector comprising:-

30 a source of electromagnetic radiation mounted within the dispenser nozzle;

means for focussing the radiation on the end of the dispensing tip; and

means for collecting the radiation coupled by a droplet on the dispensing tip.

5 25. A dispensing assembly as claimed in claim 1 in which means are provided for measuring the charge of the droplet.

26. A dispensing assembly as claimed in claim 1 in which a Faraday Pail is provided for measuring the charge of the droplet.

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27. A dispensing assembly as claimed in claim 1 in which a bottomless Faraday Pail is provided for measuring the charge of the droplet.

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28. A dispenser for discrete droplets of less than ten microlitres ($10 \mu\text{l}$) in volume of a liquid comprising:-

(A) a main assembly;

(B) a liquid container comprising:-

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an elongated body member having a straight main bore;

an inlet to the main bore;

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a valve seat in the body member forming a main bore outlet remote from and substantially in line with the inlet;

a nozzle mounted on the body member and having a nozzle bore communicating with the valve seat;

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a droplet dispensing tip on the nozzle remote from the valve seat;

a separate elongated floating valve boss of hard magnetic

5 material magnetised along its longitudinal axis loosely mounted in the main bore for limited movement out of line with the main bore, its cross-sectional area relative to that of the main bore being such as to permit the free flow of liquid between the main bore inlet and outlet by passing the valve boss, said valve boss not being mechanically connected to the body member;

10 (C) means for releasably securing the liquid container to the main assembly;

(D) means for exerting a pressure differential on the liquid in the dispenser;

15 (E) a separate valve boss actuating assembly adjacent the body member for applying an electromagnetic force to the valve boss to engage and disengage the valve boss from the valve seat;

20 (F) an electrode incorporated in the dispensing tip;

(G) a separate receiving electrode remote from the tip; and

(H) a high voltage generating means generating means connected to one of the electrodes to provide an electrostatic field therebetween.

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29. A dispensing assembly as claimed in claim 28 in which the valve boss is biased to a closed position into engagement with the valve seat by an external magnetic field generated by the actuating coil assembly.

30 30. A dispensing assembly as claimed in claim 28 in which the valve actuating assembly comprises two separate coils for moving the valve boss in opposite directions within the body member of the liquid container, a source of electrical power and a controller for varying the current over time as each droplet is being dispensed.

31. A dispensing assembly as claimed in claim 28 in which the body member and the nozzle form an integral moulding of plastics material.
- 5 32. A dispensing assembly as claimed in claim 28 comprising;
- an electrode incorporated in the dispensing tip ;
- a separate receiving electrode remote from the tip ; and
- 10 a high voltage generating means connected to one of the electrodes to provide an electrostatic field therebetween.
- 15 33. A dispensing assembly as claimed in claim 28 in which the receiving electrode is below the dispensing tip.
34. A dispensing assembly as claimed in claim 28 comprising a droplet receiving substrate mounted between the receiving electrode and the dispenser tip.
- 20 35. A dispensing assembly as claimed in claim 28 in which a droplet receiving substrate is mounted below the receiving electrode, the receiving electrode having at least one opening for the droplet to pass through to the receiving substrate.
- 25 36. A dispensing assembly as claimed in claim 28 in which there is a plurality of receiving electrodes at least one of which is activated at any time.
- 30 37. A dispensing assembly as claimed in claim 28, in which a droplet receiving substrate is mounted below a plurality of receiving electrodes, each of the receiving electrodes having at least one opening for the droplet to pass through to the receiving substrate.
38. A dispensing assembly as claimed in claim 28, in which a droplet receiving substrate is mounted below the receiving electrodes, the receiving

electrodes having at least one opening for the droplet to pass through to the receiving substrate and in which synchronous indexing means are provided for the dispenser and the receiving electrode for accurate deployment of droplets on the substrate.

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39. A dispensing assembly as claimed in claim 28, in which there is more than one receiving electrode forming droplet deflection electrodes which are mounted below the dispensing tip to provide a component of the electrostatic field substantially parallel to the receiving substrate and in which the high voltage generating means has control means to vary the voltage applied to the deflection electrodes.

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40. A dispensing assembly as claimed in claim 28 comprising a detector for sensing the separation of the droplet from the dispensing tip.

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41. A dispensing assembly as claimed in claim 28 comprising a detector for sensing the separation of the droplet from the dispensing tip, the detector comprising:-

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a source of electromagnetic radiation;

means for focussing the radiation on the end of the dispensing tip;
and

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means for collecting the radiation coupled by a droplet on the dispensing tip.

42. A dispensing assembly as claimed in claim 28, comprising a detector for sensing the separation of the droplet from the dispensing tip, the detector comprising:-

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a source of electromagnetic radiation mounted within the dispenser nozzle;

means for focussing the radiation on the end of the dispensing tip;
and

means for collecting the radiation coupled by a droplet on the
dispensing tip.

43. A dispensing assembly as claimed in claim 28 comprising a detector for sensing the separation of the droplet from the dispensing tip, the detector comprising:-

a source of electromagnetic radiation;

means for focussing the radiation on the end of the dispensing tip;
and

means for collecting the radiation coupled by a droplet on the
dispensing tip.

44. A dispensing assembly as claimed in claim 28 in which means are provided for measuring the charge of the droplet.

45. A dispensing assembly as claimed in claim 28 in which a Faraday Pail is provided for measuring the charge of the droplet.

46. A dispensing assembly as claimed in claim 28 in which a bottomless Faraday Pail is provided for measuring the charge of the droplet.

47. A dispenser for discrete droplets of less than ten microlitres (10 μ l) in volume of a liquid comprising:-

(A) a main assembly;

(B) a liquid container comprising:-

an elongated body member having a straight main bore;

an inlet to the main bore;

5 a valve seat in the body member forming a main bore outlet remote from and substantially in line with the inlet;

10 a nozzle mounted on the body member and having a nozzle bore communicating with the valve seat;

a droplet dispensing tip on the nozzle remote from the valve seat;

15 a separate elongated floating valve boss of hard magnetic material magnetised along its longitudinal axis loosely mounted in the main bore for limited movement out of line with the main bore, its cross-sectional area relative to that of the main bore being such as to permit the free flow of liquid between the main bore inlet and outlet by passing the valve boss, said valve boss not being mechanically connected to the body member;

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(C) means for releasably securing the liquid container to the main assembly;

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(D) means for exerting a pressure differential on the liquid in the dispenser;

30 (E) a separate valve boss actuating assembly adjacent the body member for applying an electromagnetic force to the valve boss to engage and disengage the valve boss from the valve seat;

(F) an electrode incorporated in the dispensing tip;

(G) a separate receiving electrode below from the tip;

(H) a high voltage generating means connected to one of the electrodes with the other electrodes maintained at a different voltage to provide an electrostatic field therebetween; and

(I) means are provided for measuring the charge of the droplet.

48. A dispensing assembly as claimed in claim 47 in which a droplet receiving substrate is mounted below the receiving electrode, the receiving electrode having at least one opening for the droplet to pass through to the receiving substrate.

49. A dispensing assembly as claimed in claim 47, in which a droplet receiving substrate is mounted below the receiving electrodes, the receiving electrode:: having at least one opening for the droplet to pass through to the receiving substrate and in which synchronous indexing means are provided for the dispenser and the receiving electrode for accurate deployment of droplets on the substrate.

50. A dispenser for discrete droplets of less than ten microlitres (10 μ l) in volume of a liquid comprising:-

(A) a main assembly;

(B) a liquid container comprising:-

an elongated body member having a straight main bore;

an inlet to the main bore;

a valve seat in the body member forming a main bore outlet remote from and substantially in line with the inlet;

a nozzle mounted on the body member and having a nozzle bore communicating with the valve seat;

5 a droplet dispensing tip on the nozzle remote from the valve seat;

10 a separate elongated floating valve boss of magnetic material loosely mounted in the main bore for limited movement out of line with the main bore, its cross-sectional area relative to that of the main bore being such as to permit the free flow of liquid between the main bore inlet and outlet by passing the valve boss, said valve boss not being mechanically connected to the body member;

15 (C) means for releasably securing the liquid container to the main assembly;

(D) means for exerting a pressure differential on the liquid in the dispenser;

20 (E) a separate valve boss actuating assembly adjacent the body member for applying an electromagnetic force to the valve boss to engage and disengage the valve boss from the valve seat;

25 (F) an electrode incorporated in the dispensing tip;

(G) a separate receiving electrode below the tip;

30 (H) a high voltage generating means connected to one of the electrodes to provide an electrostatic field therebetween; and

(I) means are provided for measuring the charge of the droplet.

51. A dispensing assembly as claimed in claim 50 in which a Faraday Pail is

provided for measuring the charge of the droplet.

52. A dispensing assembly as claimed in claim 50 in which a bottomless Faraday Fall is provided for measuring the charge of the droplet.